Centrality determination in eA collision using forward neutron based on BeAGLE

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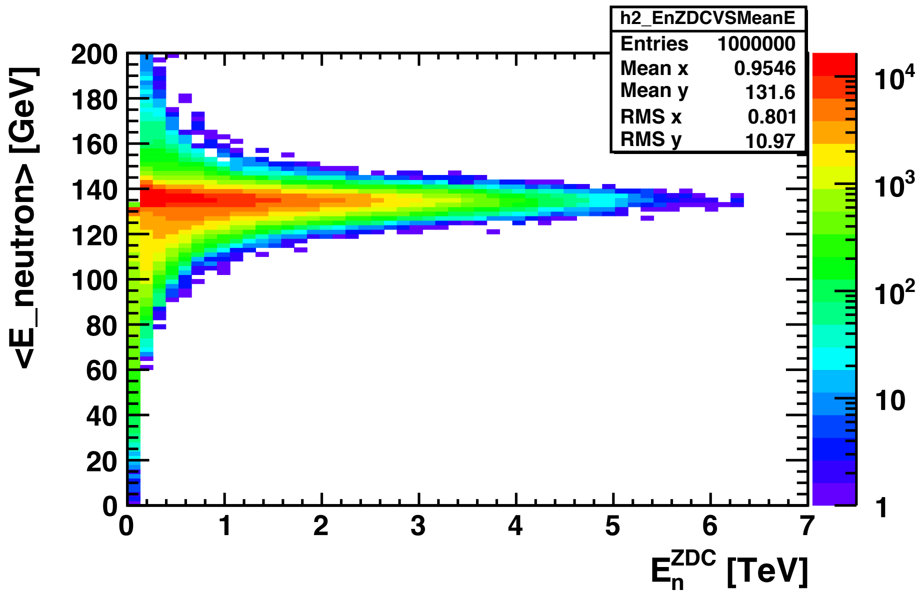
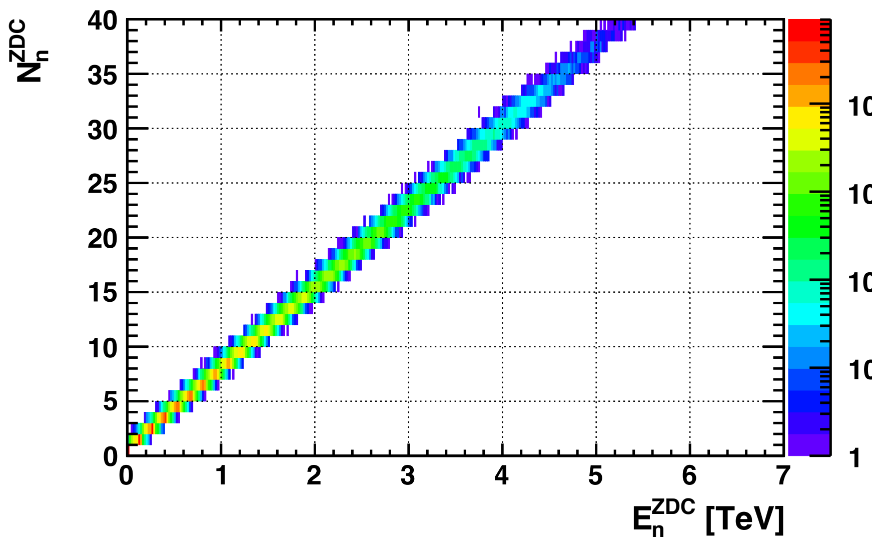
Data sample

- Input files live under: ***/eicdata/eic0002/wanchang/BeAGLE_Centrality/Shd3_tau9***
  - ePb_1M_Shd3_tau9_kt=ptfrag=0.32_noquench_US1.inp
  - eAS3noq
  - 18x135 ePb collisions. No quenching.
  - $0.01 < y < 0.95$, $1 < Q^2 < 100$ GeV^2
  - τ_0= 9 fm/c, genShd=3
  - 1M events

Original distribution

Perfect ZDC: acceptance cut is < 4 mrad

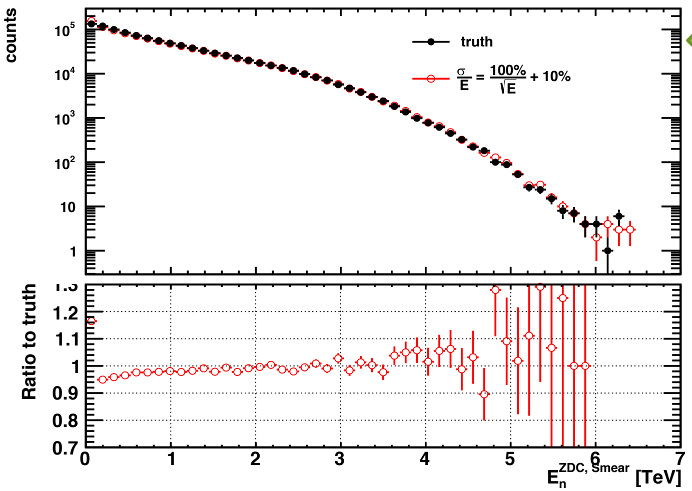




E_n^{ZDC}:generated energy deposited in ZDC
<E_neutron>: mean energy of neutron in ZDC
N_n^{ZDC}:number of neutron in ZDC

In most of events, the mean energy of neutron in ZDC is approximately equal to beam energy.

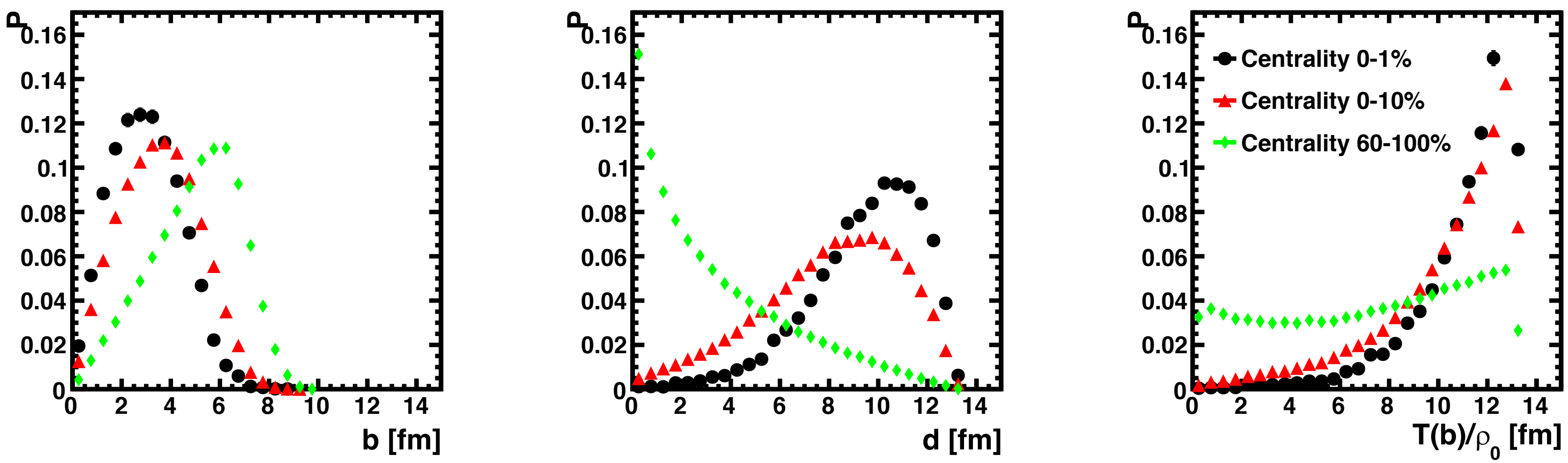
Energy deposition distribution



The distribution of energy deposition for the truth and smearing with an energy resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 10\%$

- Do smear to each individual neutron with a gaussian which has a width of the resolution.

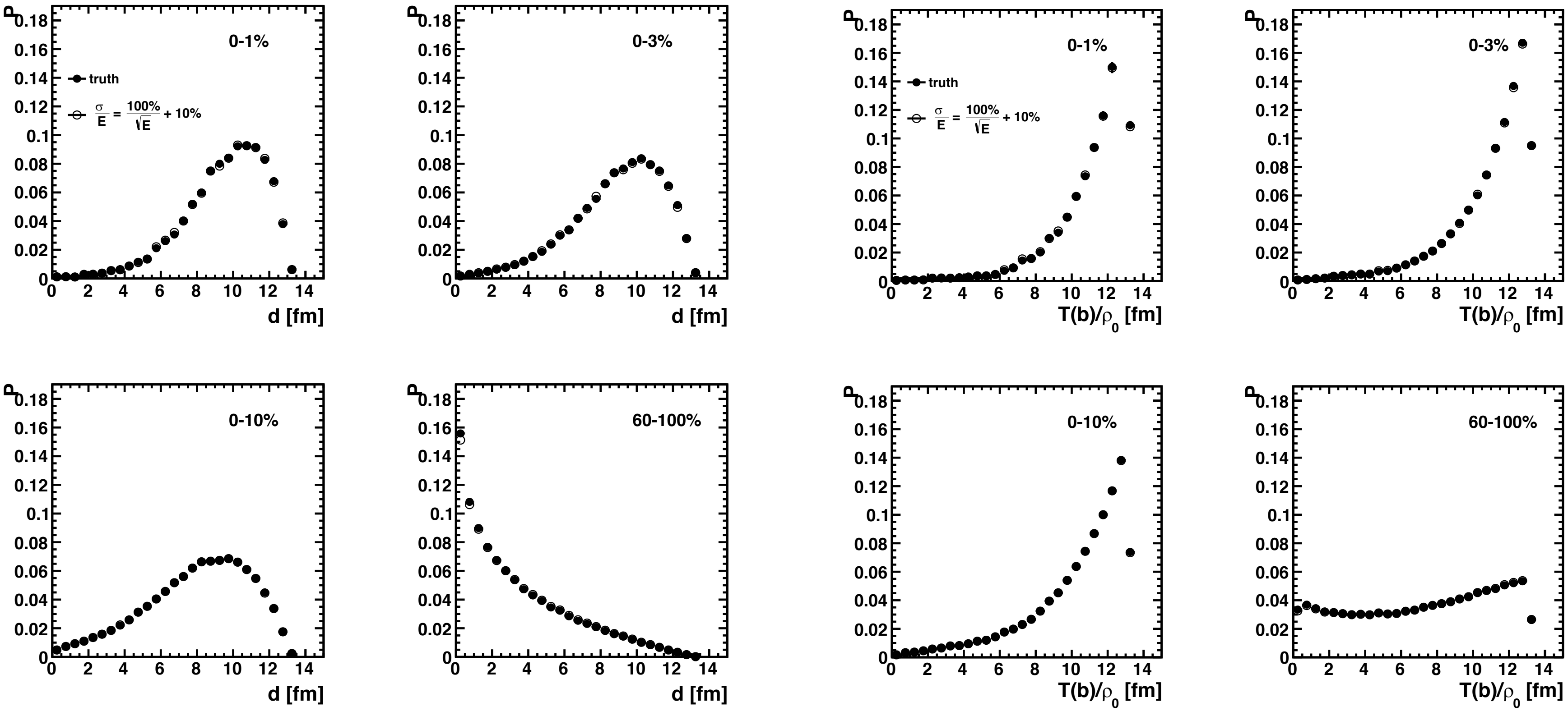
The centrality dependence of impact parameter b, traveling length d, nuclear thickness $\mathrm{T}(b)/\rho_0$



Smear by resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 10\%$

Centrality dependence

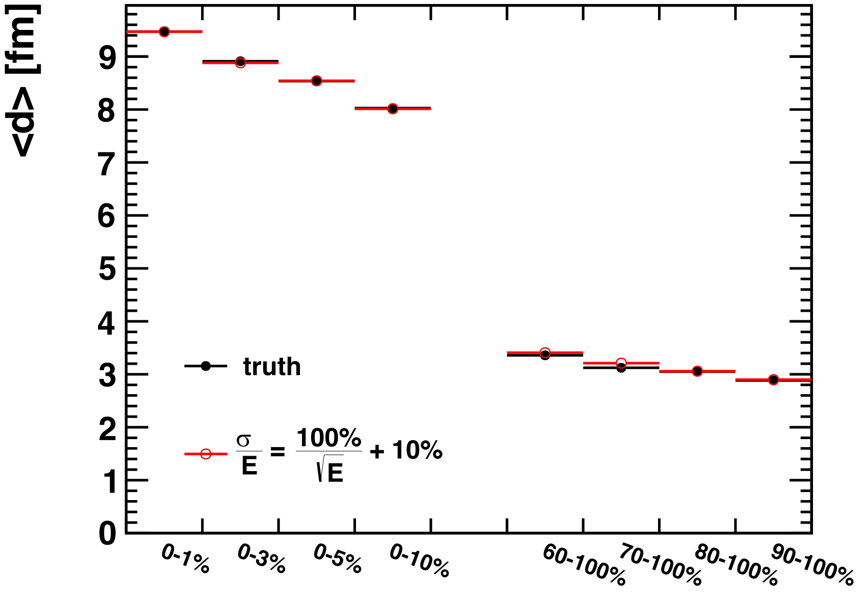
The comparison of truth and smearing with worst resolution in different centrality bins: 0-1%, 0-3%, 0-10%, 60-100%



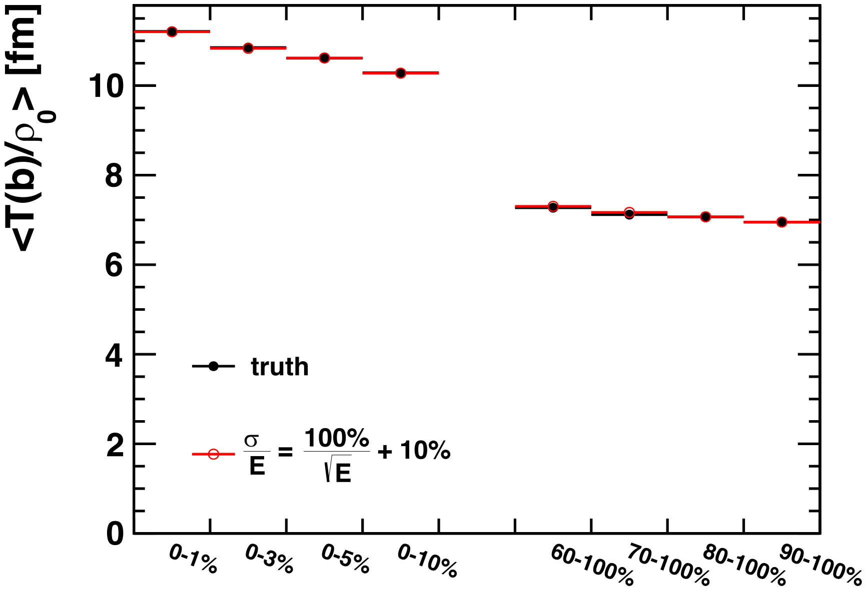
- ➢ The distribution of truth and smearing are identical.
- ➢ Making a very good calorimeter does no matter. A better calorimeter won't help.

Centrality dependence

The average value of traveling length d in different centrality bins:

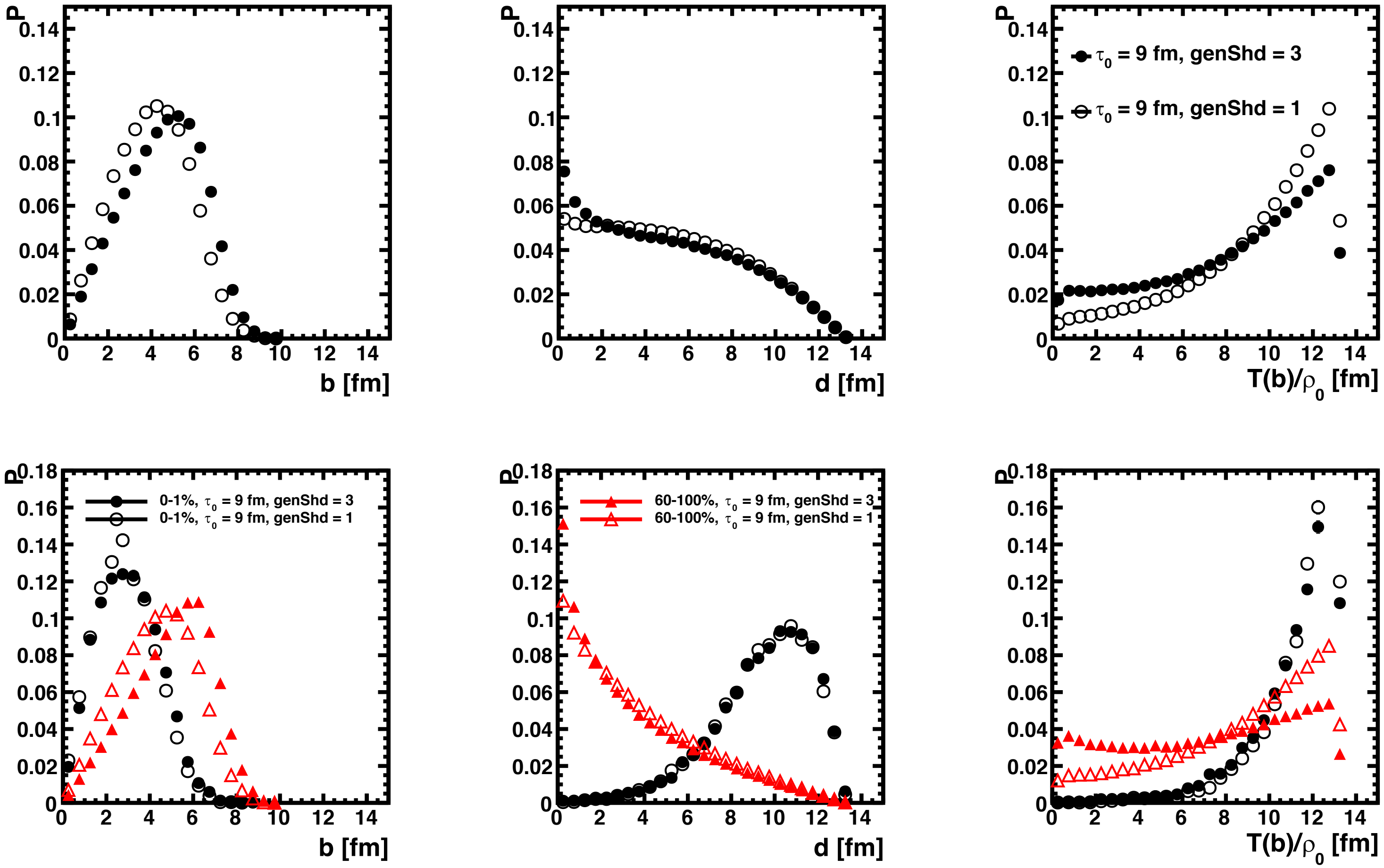


The average value of nuclear thickness $\mathrm{T}(b)/\rho_0$ in different centrality bins :



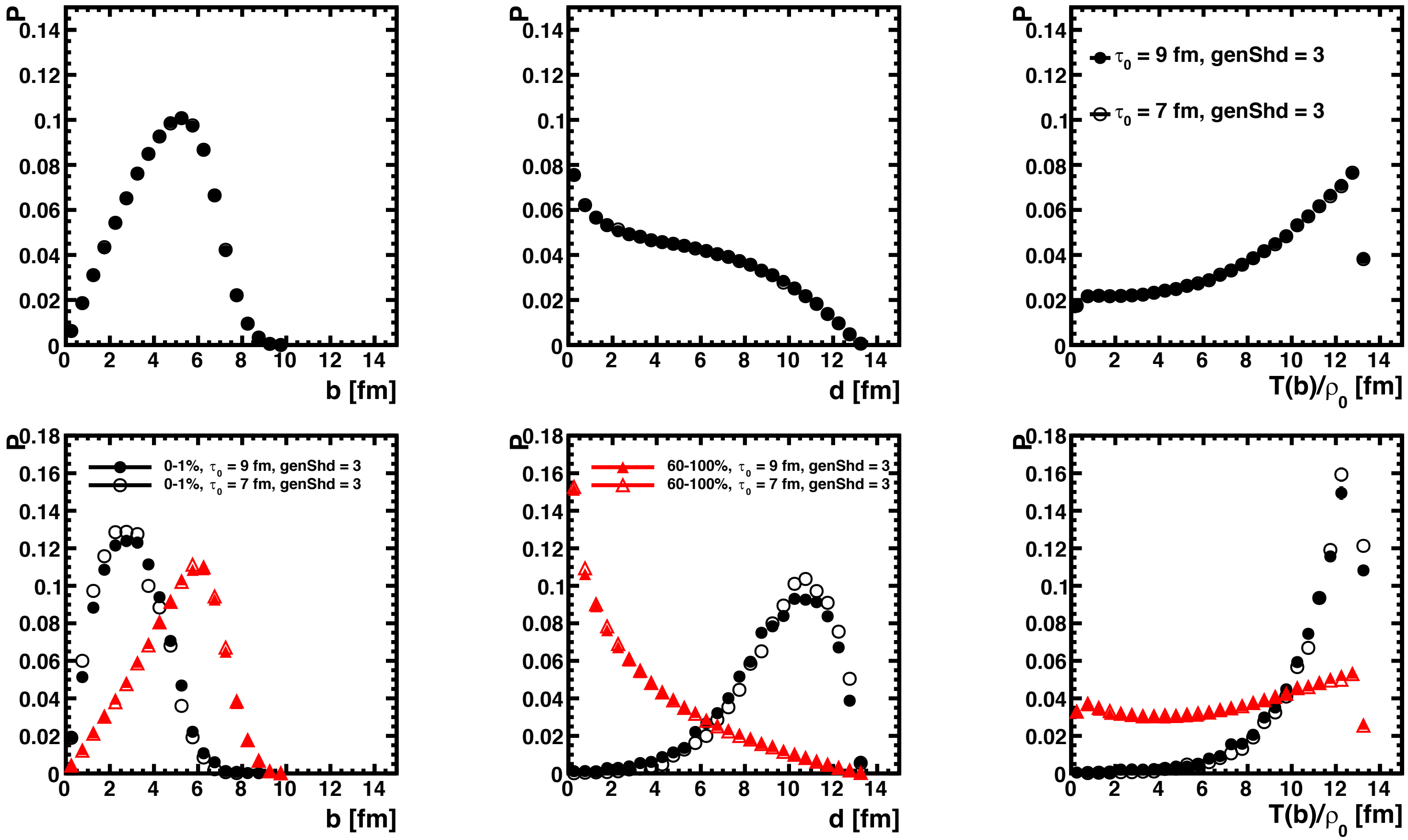
- They are almost identical for the two cases.
- The average decreases from 0-1%, 0-3% to 0-5%, 0-10%
- The decreasing trend is not obvious in peripheral collisions(60-100%, 70-100%, 80-100%, 90-100%) for each case.

genShd=3 VS. genShd=1



The influence is mainly concentrated in the peripheral collision

τ_0 = 9 VS. τ_0 = 7



No dependence on τ_0

Back up

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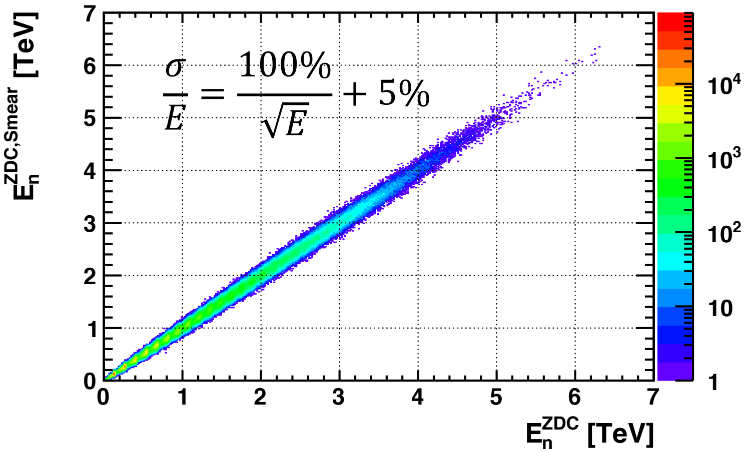
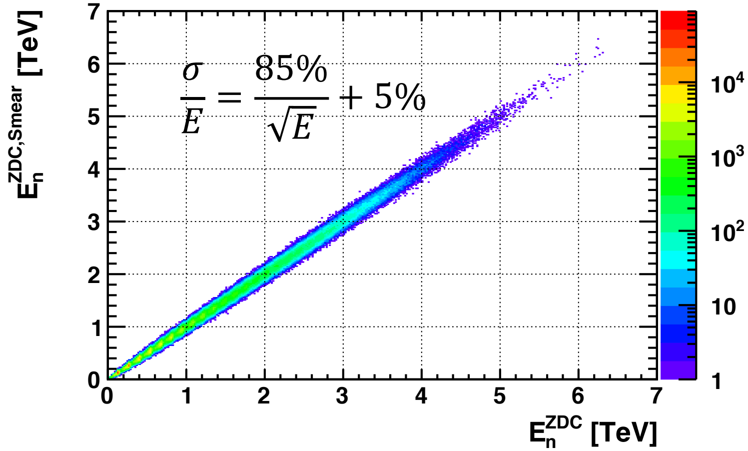
E_n^{ZDC} VS. $E_n^{ZDC,Smear}$ with different energy resolution

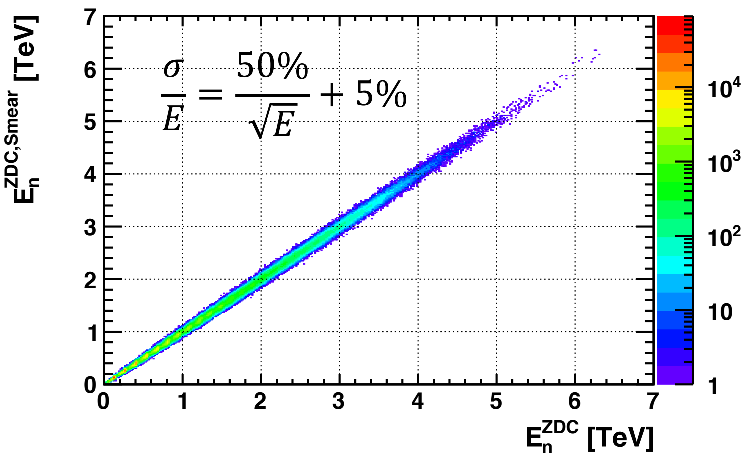
E_n^{ZDC}: energy deposited in ZDC

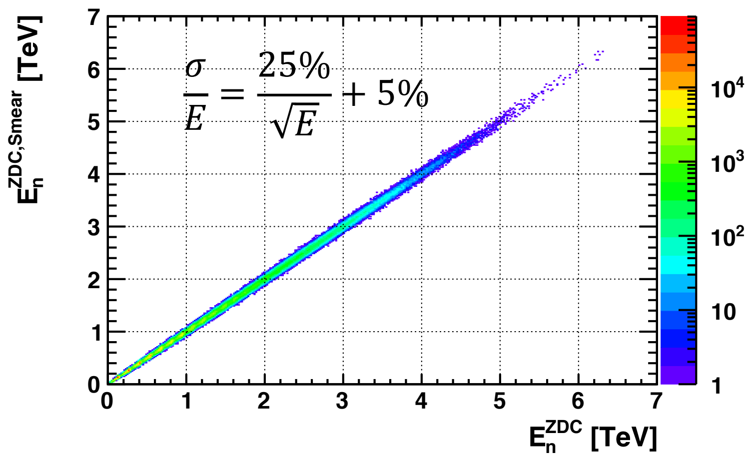
$E_n^{ZDC,Smear}$: smeared energy deposited in ZDC

Perfect ZDC: acceptance cut is < 4 mrad







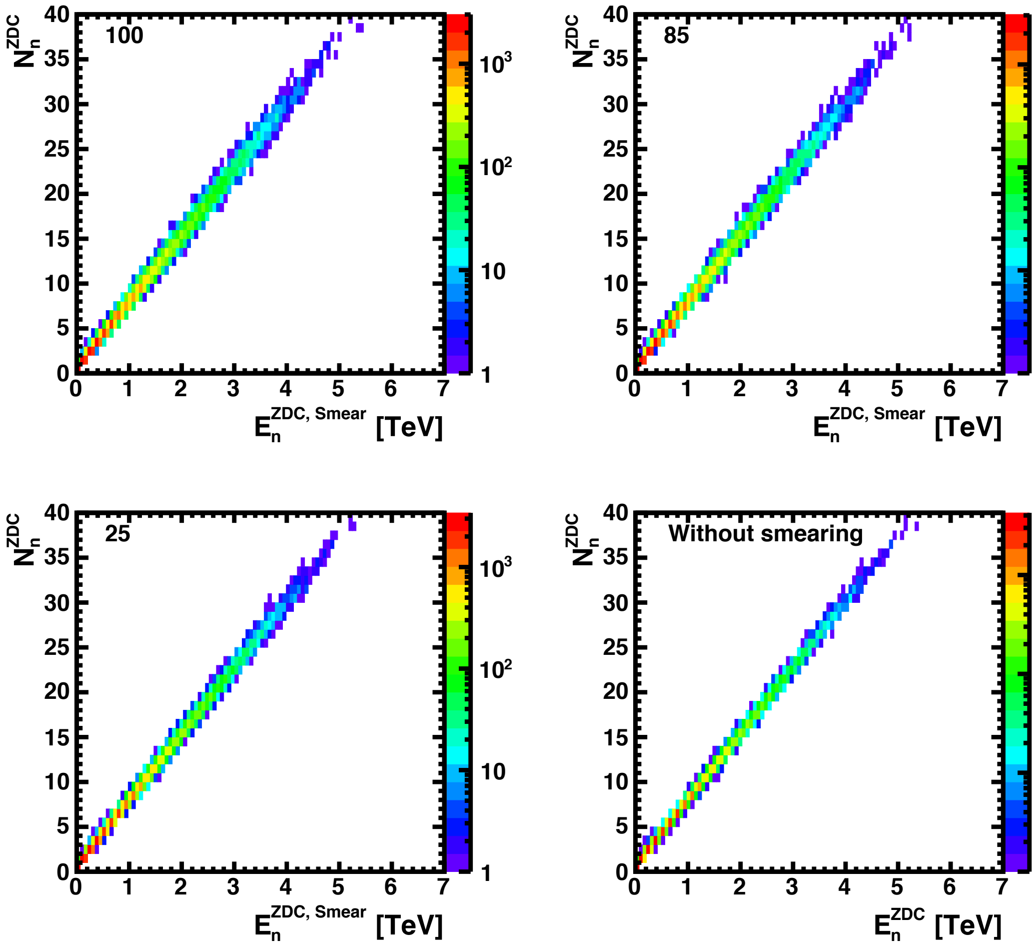


$E_n^{ZDC,Smear}$ VS. N_n^{ZDC} with different energy resolution

$E_n^{ZDC,Smear}$: smeared energy deposited in ZDC

N_n^{ZDC}: the number of neutrons in ZDC

40K events



$$\frac{\sigma}{E} = \frac{par\%}{\sqrt{E}} + 5\%$$

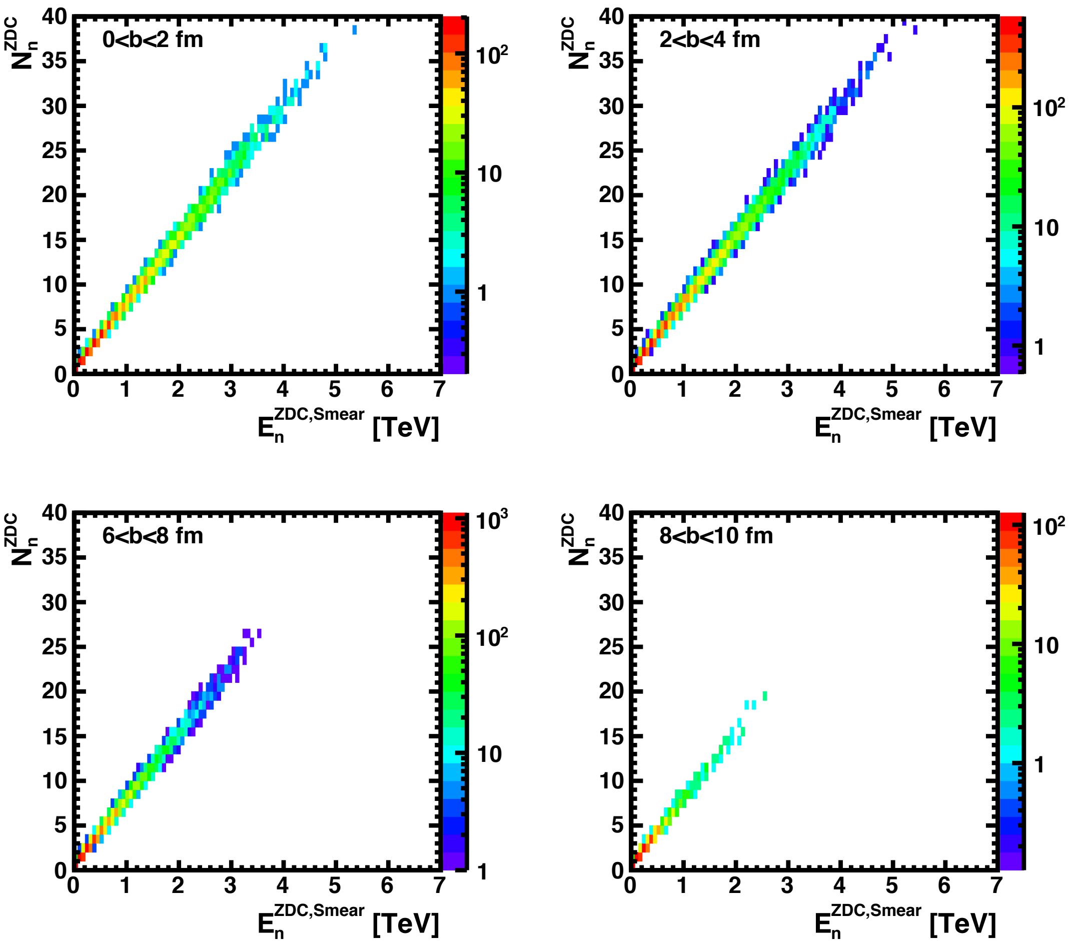
par=100, 85, 50, 25

$E_n^{ZDC,Smear}$ VS. N_n^{ZDC}

Energy resolution: $\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 5\%$

40K events

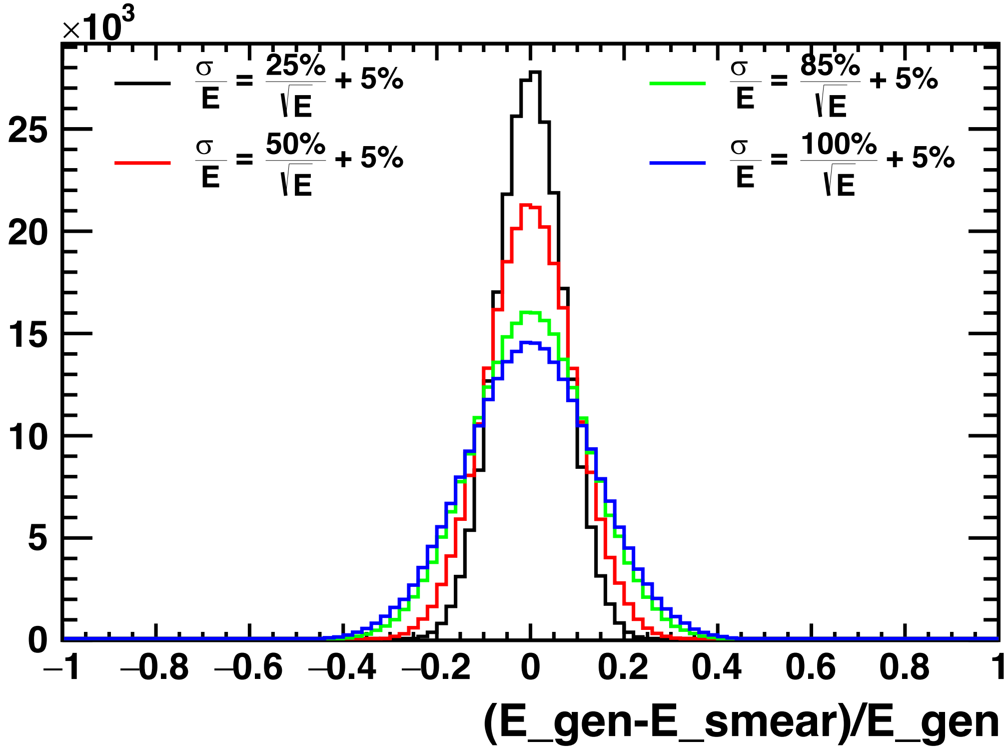
The correlation of $E_n^{ZDC,Smear}$ and N_n^{ZDC} for five slices in b: 0-2, 2-4, 4-6, 6-8, 8-10



$$\frac{\sigma}{E} = \frac{100\%}{\sqrt{E}} + 5\%$$

E_gen - E_smeared/E_Gen

Energy = particle->E;   (E_gen)
Sigma100 = (1./TMath::Sqrt(Energy) + 0.05)*Energy; (resolution sigma)
EnergySmear100 = gRandom->Gaus(Energy, Sigma100); (E_smear)

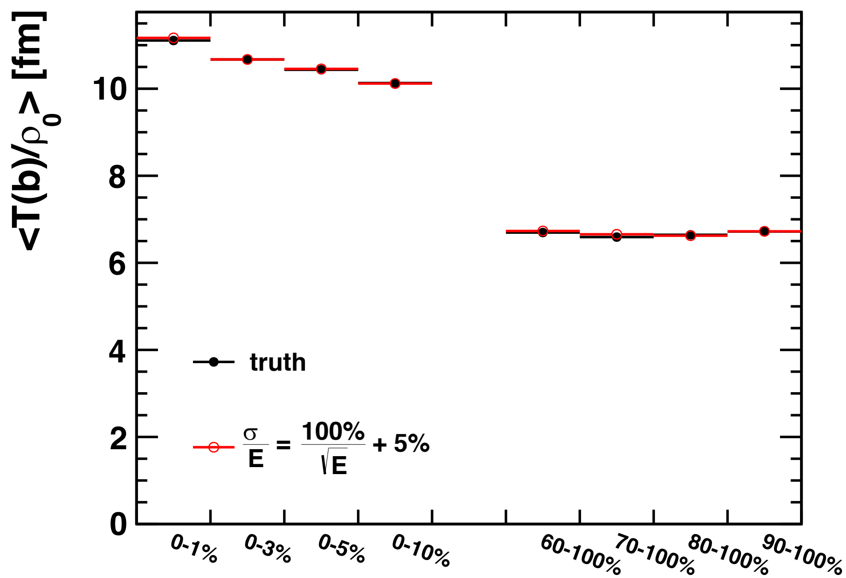


40K events

The width of these plots:

	Width
$\sigma=(\frac{1}{\sqrt{E}}+5\%)*E$	0.1373
$\sigma=(\frac{0.85}{\sqrt{E}}+5\%)*E$	0.1243
$\sigma=(\frac{0.50}{\sqrt{E}}+5\%)*E$	0.09354
$\sigma=(\frac{0.25}{\sqrt{E}}+5\%)*E$	0.07162

<T(b)> distribution

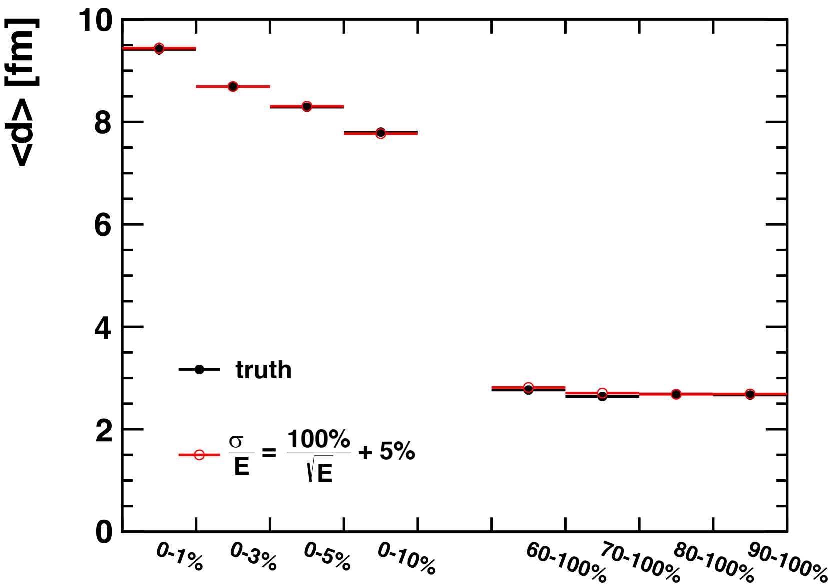


The number of <T(b)> in different centrality bins:

	truth		$\frac{\sigma}{E}=\frac{100\%}{\sqrt{E}}+5\%$	
	E_ZDC (GeV)	$\langle T(b)/\rho_0\rangle$	E_ZDC,smear (GeV)	$\langle T(b)/\rho_0\rangle$
0-1%	>3320	11.11	>3340	11.17
0-3%	>2760	10.67	>2760	10.67
0-5%	>2440	10.43	>2460	10.45
0-10%	>1960	10.13	>1960	10.12
60-100%	<400	6.696	<420	6.731
70-100%	<260	6.591	<280	6.655
80-100%	<140	6.644	<160	6.624
90-100%	<120	6.718	<100	6.723

- There is no big difference for the two cases.
- <T(b)> almost same in the peripheral collision for each case.

<d> distribution



The number of <d> in different centrality bins:

	truth		$\frac{\sigma}{E}=\frac{100\%}{\sqrt{E}}+5\%$	
	E_ZDC (GeV)	$\langle d \rangle$	E_ZDC,smear (GeV)	$\langle d \rangle$
0-1%	>3320	9.415	>3340	9.439
0-3%	>2760	8.686	>2760	8.691
0-5%	>2440	8.287	>2460	8.305
0-10%	>1960	7.801	>1960	7.771
60-100%	<400	2.764	<420	2.816
70-100%	<260	2.639	<280	2.707
80-100%	<140	2.69	<160	2.683
90-100%	<120	2.667	<100	2.689

- There is no big difference for the two cases.
- <T(b)> almost same in the peripheral collision for each case.